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1987, 1988 HOT-MIX TRIALS WITH POLYMER MODIFIED ASPHALT CEMENT - A CONSTRUCTION REPORT

MATERIALS INFORMATION

ENGINEERING MATERIALS OFFICE

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SUMMARY

Polymer modified asphalt cements are claimed to produce more durable hot-mix pavements. The Ontario Ministry of Transportation constructed four trials using a proprietary polymer modified asphalt cement called "Styrelf" to establish the mixing, handling, laying, compaction and long term performance relative to control mixes on the same project.

This report contains the location of the trials, mix design data, observations at time of construction and the visual appraisal of two trials after one winter in service.

It is anticipated that it will take at least five years of annual monitoring before any conclusions on relative performance can be made.

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1 INTRODUCTION

Over the 1987 and 1988 construction seasons, trials of Styrelf hot-mixed asphaltic concrete were included in four paving contracts . Styrelf is a polymer modified asphalt which is claimed to produce a longer lasting pavement through:

less age hardening,
higher viscosities at high temperature,
higher ductilities at low temperature,
improved asphalt-aggregate adhesion,
increased tensile strength and
elastic memory.

Styrelf hot mix, it was claimed, would improve cold temperature flexibility and resist cracking and rutting.

In order to validate the claims made for the product, a limited number of trials were constructed utilizing different materials and environments.

On all of the four contracts, one tanker load of the same grade of Styrelf, (approximately 30t), was substituted for the standard asphalt cement. In addition, on one contract in northern Ontario, a tanker of one grade softer Styrelf was used to compare relative performance of resistance to thermal cracking.

The Styrelf used in the trials was manufactured by Polymac Engineered Asphalts Corp., a Canadian joint venture of McAsphalt Industries Limited and Elf Canada Limited.

2 FIELD TRIALS

2.1 Trial #1 Barrie Area

Cont. 87-03, Hwy. #131 between Highways #27 and #90
1987 AADT = 2,350

2.1.1 Location

The Styrelf mix was placed as part of the 40 mm HL-4 surface course from:
- Hwy. #90 southerly 410 m, in the northbound lane to the CNR railway tracks,
- Hwy. #90 southerly approximately 200 m in the southbound lane.

This mix was placed over a 40 mm standard HL-4 binder course over an existing pavement.

See key map in the appendix for more detail.

2.1.2 Mix Design

The HL-4 mix design, (control) consisted of:
45% coarse aggregate (Cook stone),
37% fine aggregate (Cook sand),
18% fine aggregate (Cook screenings),
5.6%, 85-100 grade asphalt cement (by weight of aggregate).

This mix was modified for the trial by the straight substitution of 85-100 grade Styrelf for the normal asphalt cement.

2.1.3 Mix Production

The mix was produced in Cook's CMI drum-mix plant at their Barrie yard. No problems were encountered producing the Styrelf mix at the hot mix plant.

2.1.4 Mix Placement

The Styrelf mix was placed during the morning of 87 10 29 with an initial ambient air temperature of 2° C and a mix temperature of 135° C. The hand work required to produce the starting joint proved to be most difficult because the Styrelf mix was very sticky.

The mix came out from under the paver screed in a normal fashion but the surface had many small fat spots (dime size) which appeared to be an accumulation of asphalt and fines.

2.1.5 Mix Compaction

Break-down compaction was achieved with a dual drum vibratory roller operated in vibratory mode. A pneumatic tire roller was used for intermediate/finish rolling.
At one point the water spray on one of the steel drums of the break-down roller quit and the Styrelf mix picked up almost instantly onto the drum to a thickness of 10-15 mm.

When the pneumatic roller came onto the mat, the mix picked up excessively onto the tires. After a laborious cleaning, the tires were sprayed with a mixture of water and liquid dish detergent. This treatment repeated at about five minute intervals, minimized pick-up, provided the mat was less than 75° C. If the mix was over 75° C mix pick-up was excessive, regardless of the frequency of detergent solution application.

2.2 Trial #2 Toronto Area

Cont. 87-54, Hwy. #7 between Pine Valley Dr. and Weston Rd.
1987 AADT = 42,500

2.2.1 Location

Highway #7 at this location is three lanes wide in both east and west bound directions.

The Styrelf mix was placed as part of the 40 mm DFC surface course in the centre and left lanes, west bound, from Sta. 17+338 to Sta. 18+336. See key map in the appendix for more detail.

This mix was placed over a 50 mm recycled hot mix binder course over recycled hot mix padding on a cold milled existing pavement.

2.2.2 Mix Design

The DFC mix design, (control) consisted of:
48% coarse aggregate (Dofasco Steel Slag),
52% fine aggregate (Dofasco Steel Slag),
5.9%, 85-100 grade asphalt cement (by weight of aggregate).

This mix was modified for the trial by the straight substitution of 85-100 grade Styrelf for the normal asphalt cement.

2.2.3 Mix Production

The mix was produced by Warren Bitulithic Limited in their batch plant in Downsview. No problems were encountered in producing the Styrelf mix at the hot mix plant.

2.2.4 Mix Placement

The trial mix was placed in mid November 1987 under favorable conditions. The project staff reported that there were no observable differences in placing the Styrelf mix from the control mix.

2.2.5 Mix Compaction

A conventional static rolling train consisting of a 9t steel drum breakdown, an 8t pneumatic tire intermediate and a 7t steel drum finishing roller was used to compact the mat. Field staff reported that there was no problem of pick-up on the pneumatic tires when compacting either the control or the Styrelf mix.

2.3 Trial #3 Kirby Area

Cont. 86-87, Hwy. #35/115 between Orono and Enterprise Hill.
1987 AADT = 14,300

2.3.1 Location

Highway #35/115 at this location is a four lane divided highway.

The Styrelf mix was placed as part of the 40 mm DFC surface course in the north bound lanes from Sta. 24+600 to Sta. 25+600. See key map in the appendix for more detail.

This mix was placed over 160 mm of recycled hot mix binder course, placed in three lifts over a granular grade.

2.3.2 Mix Design

The DFC mix design, (control) consisted of:
45% coarse aggregate (Havelock Traprock),
55% fine aggregate (Marmora Traprock Screenings),
4.5%, 85-100 grade asphalt cement (by weight of aggregate).

This mix was modified for the trial by the straight substitution of 85-100 grade Styrelf for the normal asphalt cement.

2.3.3 Mix Production

The mix was produced by Armbro Construction and Materials Limited in their CMI drum-mix plant located in a nearby gravel pit. No problems were encountered producing the Styrelf mix at the hot mix plant.

2.3.4 Mix Placement

The mix was placed on 88 05 26, a warm sunny day. The passing lane was paved first with a mix temperature behind the screed of 158° C. The mix appeared dry and "dead" as though it had been overheated. After paving 1 km the paving operation was moved back to pave the driving lane. The mix in this lane appeared much richer and felt tacky under foot. This tackiness was not present in the passing lane.

After completion of the trial area the contractor switched back to the control mix which was observed to be noticeably more workable than the Styrelf mix.

2.3.5 Mix Compaction

Break-down compaction was achieved with a dual drum vibratory roller operated in the vibratory mode. A pneumatic tire roller was used for intermediate rolling followed by a static steel drum finishing roller.

Even though the mix in the passing lane lacked tackiness, it picked up on the pneumatic tires of the intermediate roller. If the mix was over 78° C, the mix pick-up was excessive and the roller had to back off. When the operation switched to the driving lane the pick-up was less severe even though the mix was stickier. This may have been due to the pneumatic tires being warmer. Pick-up was not a problem on the standard mix.

2.4 Trial #4 Cochrane Area

Cont. 88-205, Hwy. #11 between Matheson and Cochrane.
1887 AADT = 1,500

2.4.1 Location

Two grades of Styrelf were used in recycled hot mix (RHM) on this project in various combinations. They are as follows:

- 500+ A.C. surface course over Styrelf 800+ binder over granular grade,
- Styrelf 800+ surface course over Styrelf 800+ binder over granular grade,
- Styrelf 800+ surface course over Styrelf 500+ binder over granular grade,
- Styrelf 500+ surface course over Styrelf 500+ binder over granular grade,
- Styrelf 500+ surface course over Styrelf 500+ rut padding over existing pavement.

See key map in the appendix for actual locations.

2.4.2 Mix Design

The RHM binder mix design, (control) consisted of:
50% crushed RAP
28% coarse aggregate (Humpheries Pit),
22% fine aggregate (Town of Iroquois Falls Pit),
2.67%, (4.9% total) 500+ grade asphalt cement (by weight of aggregate).

The RHM surface mix design, (control) consisted of:
45% crushed RAP
30% coarse aggregate (Humpheries Pit),
25% fine aggregate (Town of Iroquois Falls Pit),
2.90%, (4.9% total) 500+ grade asphalt cement (by weight of aggregate).

These mixes were modified for the trial by the straight substitution of either 500+ grade Styrelf or 800+ grade Styrelf for the normal asphalt cement depending on the application.

2.4.3 Mix Production

The mix was produced by Armbro Construction and Materials Limited in their CMI drum-mix plant located in a nearby gravel pit. No problems were encountered producing the Styrelf mix at the hot mix plant.

2.4.4 Mix Placement

The trial mixes were placed between August 22nd. and 27th., 1988 inclusive with ambient temperatures ranging between 15 and 20° C under mostly sunny skys.

The truckers commented that the Styrelf mixes came out of the truck box more cleanly than did the RHM control mixes.

The Styrelf mixes passed through the paver and came off the screed the same as the control mixes. One minor difference was that a mucous-like trail of asphalt and fines were observed hanging on to the trailing edge of the screed. These trailings would drop off in small gobs creating occasional fat spots about the size of a dime on the mat surface.

Hand work was found to be easier with the Styrelf mixes than with the control mixes. Workmen making the joints commented that the Styrelf mix handled more like a virgin mix.

2.4.5 Mix Compaction

Break-down compaction was achieved with a dual drum vibratory roller operated in the static mode. A 25 t pneumatic tire roller was used for intermediate/finish rolling.

The pneumatic tire roller was initially kept back due to fear of pick-up; but, as the work progressed it was brought up to a normal distance behind the paver without any problems.

2.4.6 Sampling and Testing

Samples of all the mix components as well as samples of each mix produced were obtained for evaluation in the Downsview laboratory.

The Bituminous Section will be producing a separate report on this project.

3 DEGREE-DAYS FOR TEST SITES

Degree-days may be used as an indicator of the temperature conditions of a particular area. Of the four trial areas, Cochrane has the most freezing degree-days and the least number of days greater than 18°C, whereas Toronto has the least freezing degree-days and the most degree-days greater than 18°C. The following table provides data for the four trial areas.

	Annual Total Degree-Days (°C)		
Location	≤ 0°	≥ 5°	≥ 18°
Barrie	500-1000	2000-2250	200-300
Cochrane	1500-2000	1250-1500	50-100
Kirby	500-1000	2000-2250	200-300
Toronto	250-500	2250-2500	300-400

4 FIELD EVALUATIONS

3.1 Summer 1988

The two trials constructed in 1987 (Barrie and Toronto areas) were visually inspected after one winter and spring in service. No observable difference between the control and Styrelf mixes was evident.

5 COSTS

The Styrelf asphalt costs $150.00 more than the equivalent standard penetration grade asphalt before taxes. Using typical 1988 prices for an 85-100 grade asphalt, including Federal and Provincial taxes FOB supplier, we find:

Styrelf A.C.	$385.00
Regular A.C.	$210.00
Difference	$175.00

Styrelf hot-mix @ 5% binder	$44.25
Regular hot-mix @ 5% binder	$35.50
Difference	$8.75

This $8.75 is equivalent to approximately a 25% increase in cost over regular hot-mix. This 25% is exclusive of any premium a contractor may charge for handling or processing.

6 DISCUSSION

No difference was noticed in producing the Styrelf mixes versus regular mixes in the three hot-mix plants encountered in these trials.

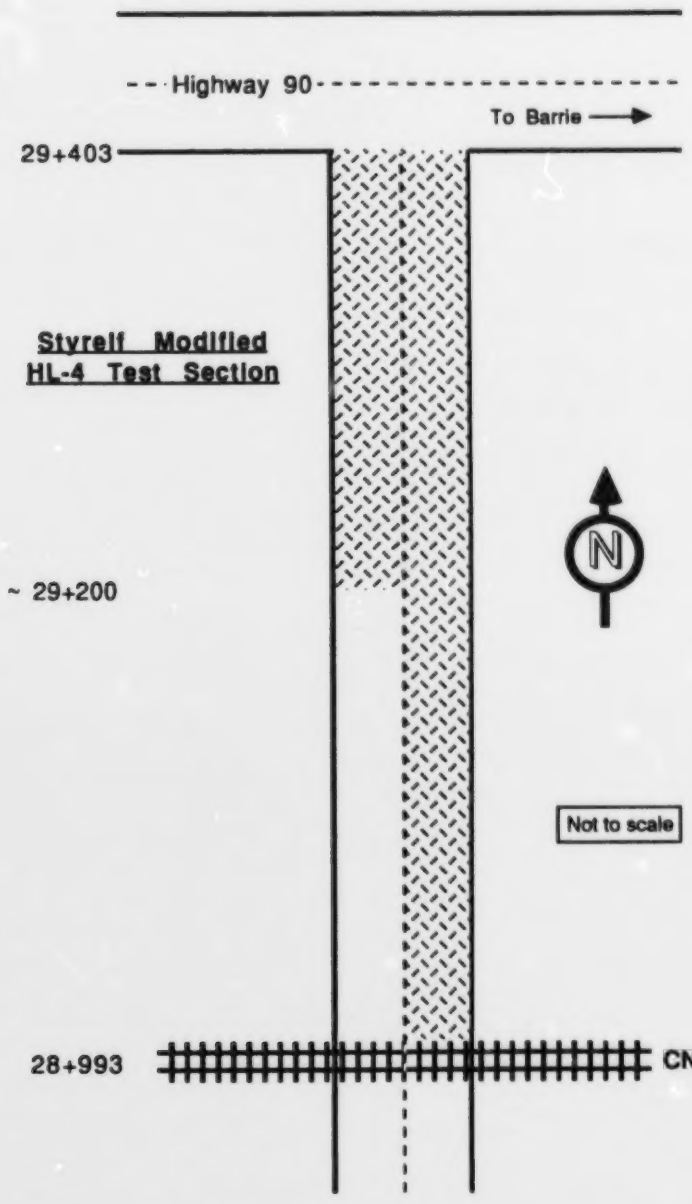
Machine laying of Styrelf mix was found to be virtually the same as regular mixes but hand work was more difficult than a virgin mix and less difficult than a recycled mix.

During compaction, pick-up was a problem on the tires of the pneumatic rollers on half the projects.

The increased cost of Styrelf hot mix (~25% in 1988), will have to be justified by improved performance over regular hot mix. It will likely take five years or more of evaluations before any meaningful difference in performance will be discernable.

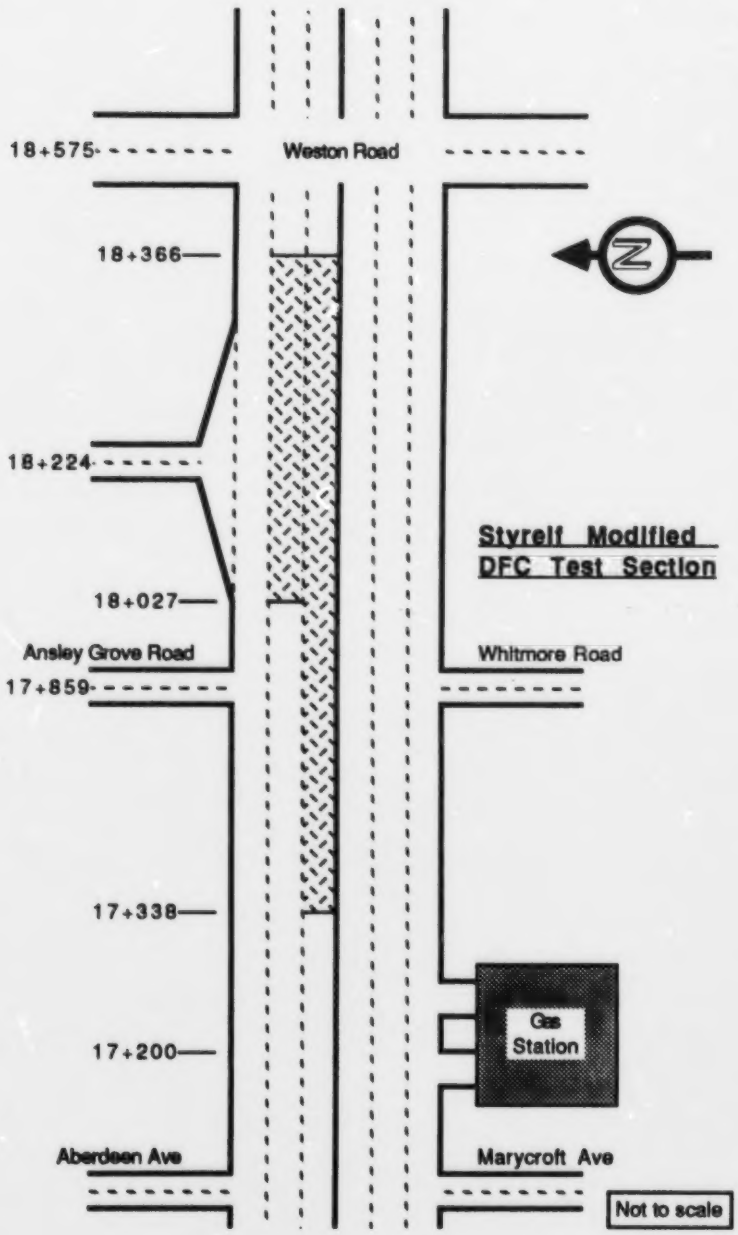
The Bituminous Section will continue to monitor the trials on an annual basis.

KEY MAP: TRIAL #1, BARRIE AREA



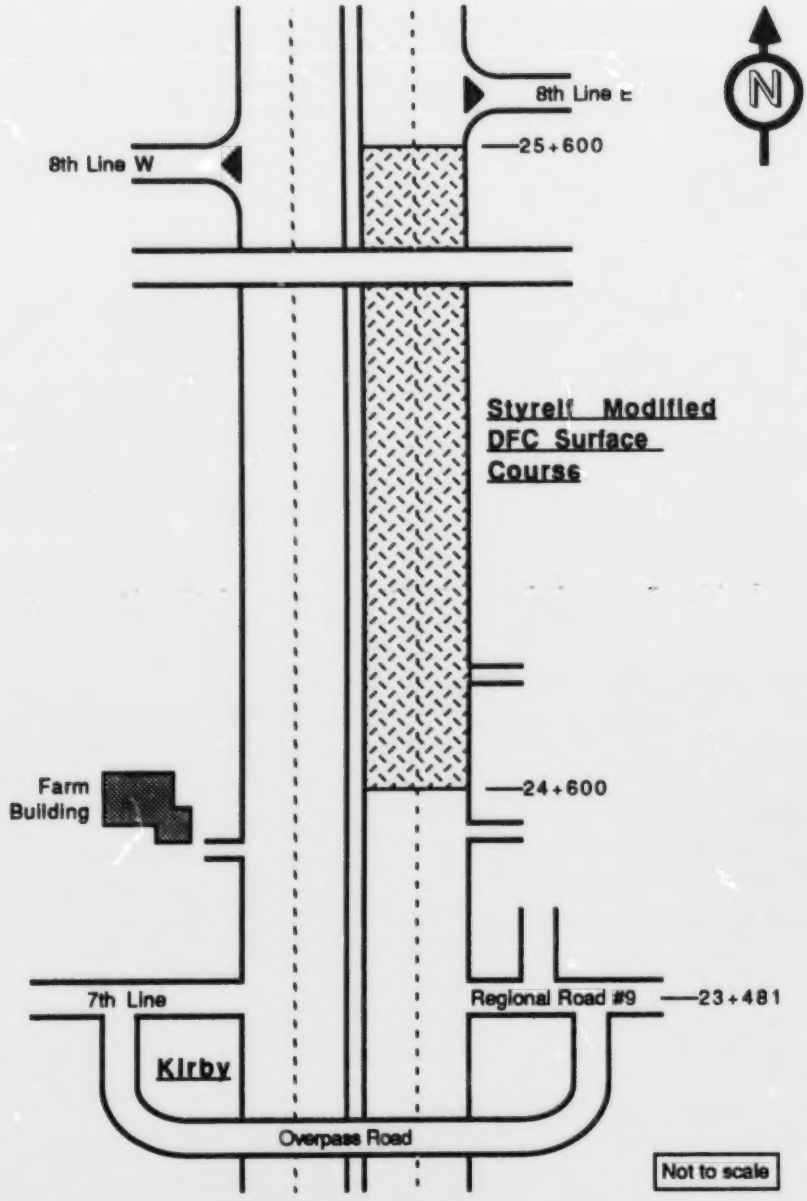
Highway 131, HL-4 Surface Course

KEY MAP: TRIAL #2, TORONTO AREA



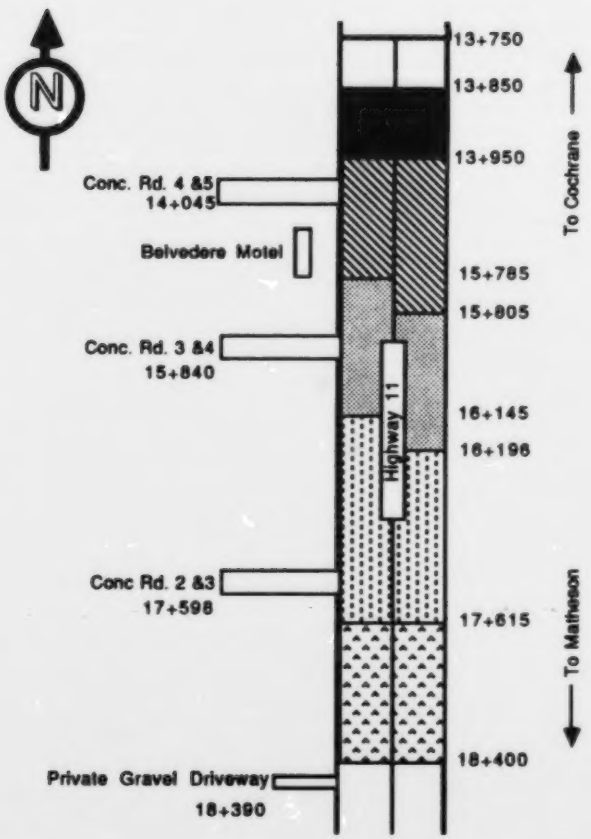
Highway 7, DFC Surface Course

KEY MAP: TRIAL #3, KIRBY AREA



Highway 35/115, DFC Surface Course

KEY MAP: TRIAL #4, COCHRANE AREA



500+ Regular A.C. mix surface and binder courses on granular grade.

500+ Regular A.C. mix surface course and 800+ polymer modified binder course on granular grade.

800+ Polymer modified surface and binder courses on granular grade.

800+ Polymer modified surface course and 500+ polymer modified binder course on granular grade.

500+ Polymer modified surface and binder courses on granular grade.

500+ Polymer modified surface course and rut padding (with grader) on existing pavement.

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